P228

CARTILAGE LOSS IN OSTEOARTHRITIS DETECTED BY STATISTICAL SHAPE ANALYSIS OF MAGNETIC RESONANCE IMAGES

TG Williams[1], AP Holmes[2], RA Maciewicz[2], JC Waterton[2], CJ Taylor[1], P Creamer[3], AFP Nash[2]
[1]ISBE, University of Manchester, Manchester, United Kingdom; [2]R&I, AstraZeneca, Macclesfield, United Kingdom; [3]NHS Trust, Southmead Hospital, Bristol, United Kingdom

If tiny cartilage volume changes are to be measured by MRI, errors in image segmentation must be minimised, and small focal changes must be measured. We reasoned that errors arise at the edges of articulating surfaces, which are difficult to segment yet may be little involved in the disease process. Additionally changes in specific compartments may be obscured by whole joint analysis.

Aim: To assess measures of cartilage volume, normalised for bone shape, within anatomically equivalent regions on the bone surface identified by Statistical Shape Modelling, for the detection of tiny morphologic change in MRI of knee osteoarthritis (OA).

Methods: Following IRB approval and informed written consent, 33 patient-volunteers (female, aged 50-85, BMI $\geq$30) with knee OA (K/L 2 or 3) and current knee pain on walking ($\geq$4 on a 10 scale) were imaged using MRI (3D gradient echo with/without fat saturation) at baseline and 6 months at three centres. Two datasets were excluded due to poor image quality or incorrect pulse sequence, and a third from the patella analysis due to incomplete segmentation. Similarly, data were collected for 19 healthy female volunteers: their endosteal bone surfaces were segmented by hand and a Minimum Description Length Statistical Shape Model (SSM) was built from the surfaces. An SSM provides a mean shape, represented as a dense point set and triangular connecting facets, and modes of shape variation. The facets are propagated, in an anatomically consistent manor, to any instance of the model. 'Expected' ('trimmed') cartilage coverage was defined as the set of facets that exhibited $\geq$90% coverage across the healthy volunteers.

For the patient-volunteers an Active Shape Model, built from the SSM, was used to obtain automatically segmentations of the bone. The cartilage surfaces were identified manually by two trained, non-expert segmentors. A measure of cartilage volume, normalised for differences in bone shape and size, was calculated by measuring thickness at each bone facet and multiplying by the facet's area on the average bone shape. This was computed for each compartment, and three femoral sub-compartments, over 'untrimmed' and 'trimmed' regions.

Results: Cartilage volume, normalised for bone shape and size, showed no significant change over the individual compartments' 'untrimmed' region. In the 'trimmed' region, significant cartilage volume loss was detected in the total knee (n=30, -0.241 ml, P<0.01, one sample t-test) and whole femoral compartment (n=31, -0.168 ml, P<0.01). Analysis of sub-regions of the 'trimmed' femoral compartment showed significant loss in the medial condyle (n=31, -0.092 ml, P<0.05 Bonferroni corrected).

Conclusions: Statistical shape modelling of bone surfaces permits the identification of anatomically equivalent regions, and the ability to consistently trim, based on the imputed pre-morbid state. These provide sensitive measures, permitting detection of tiny morphologic change in cartilage thickness over six months in a small study.

P229

CAN PATTERNS OF PATELLAR KINEMATICS BE DETERMINED FROM ONE ANGLE OF KNEE FLEXION?

EJ McWalter[1], NJ MacIntyre[2], J Cibere, DR Wilson
[1]Mechanical Engineering, University of British Columbia, Vancouver, BC, Canada; [2]School of Rehabilitation Therapy, Queen's University, Kingston, ON, Canada; [3]Department of Rheumatology, University of British Columbia and Arthritis Research Centre of Canada, Vancouver, BC, Canada; [4]Department of Orthopaedics, University of British Columbia, Vancouver, BC, Canada

Aim: Static measurements of patellar alignment (obtained from radiographs) are widely used to assess patellofemoral mechanics in cases of suspected knee osteoarthritis. A limitation of this approach is that it does not describe the changing relationship of the patella to the femur through the range of knee flexion. Our aim was to determine whether there is an association between static patellar alignment and patterns of patellar kinematics.

Methods: We assessed 3D patellar kinematics through approximately 40° of loaded flexion in 70 subjects (28 female, 42 male, age 38±8) using a validated MRI-based method. Subjects included 10 with early knee OA, 40 with patellofemoral pain syndrome and 20 asymptomatic controls. We fit linear, quadratic and cubic regression models to each subject's patterns of patellar tilt and lateral translation as a function of flexion angle. We assessed the association between alignment (measurement of the parameter at full extension) and movement pattern (slope of linear fit to kinematic measurement as a function of flexion angle) using scatter plots and the Pearson Correlation Coefficient.

Results: There was a moderate correlation between medial alignment of the patella at extension and lateral translation of the patella with flexion (r = 0.72, p<0.001) (Fig. 1). There was also a moderate correlation between lateral tilt of the patella at full extension and medial tilting with flexion (r = 0.67, p<0.001) (Fig. 2). While none of the regression models studied was ideal for describing the measured patterns of patellar tilt and lateral translation, the linear model provided the best fits to kinematic patterns.

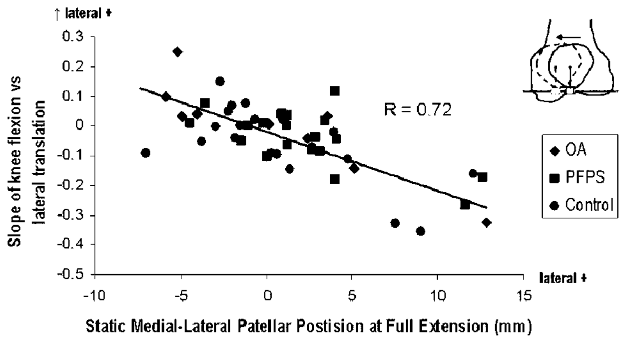

Fig. 1. Static medial-lateral patellar position at full extension vs change in medial-lateral position with knee flexion.

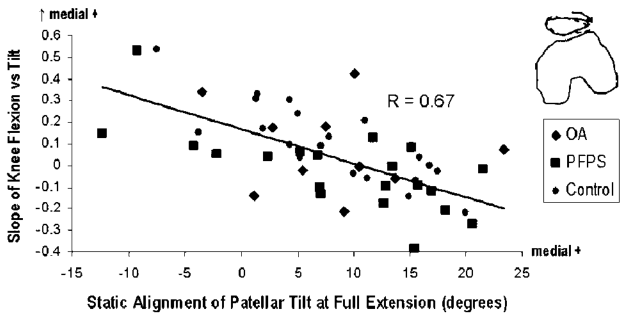

Fig. 2. Static patellar tilt at full extension vs change in tilt with knee flexion.